Colburn 14

Hatchery Wastewater and Effluent Analysis

Hatchery Wastewater Summary

All fish culture stations discharge wastewater that contains a limited set of metabolically generated waste products. The major waste products include phosphorus, nitrogen, solids and carbon dioxide. Fish metabolic activity also consumes oxygen and increases the biochemical oxygen demand in the wastewater. While these potential sources of waste generation have been a source of concern within the PFBC system, technologies and management practices designed to reduce the impact are being utilized at each of the fifteen PFBC stations. These treatment technologies and management practices include diet manipulation, feeding regimes, quiescent zones, flow baffles, clarifiers, and settling ponds. Table 6 provides a summary of the wastewater treatment practices that are currently in place and proposed for within the PFBC system. These practices have allowed the PFBC system to operate within the numeric criteria set forth in the NPDES permits. While some instantaneous and isolated concentration exceedences have occurred, continuous violations of numeric permit limits have not been observed (see Table 5). Annual mass loading to receiving streams is well under the permitted criteria for all facilities. However, benthic impacts to the receiving streams (discussed later in this document) remain a concern.

Treatment technologies and management practices can be divided into five tiers or levels. Table 6, Figure 4 and Figure 5 illustrate the treatment tiers. The first tier utilizes detailed data from the hatchery to develop best management practices (BMP's) aimed at producing a high quality fish while reducing potential waste. Tier 1 targets the solids produced in the rearing units and their collection and separation from overflow water. Included in the first tier are diet manipulation, feeding regimes, flow baffles, quiescent zones, and solids clarification systems. Tier 1 effluent management practices in place within the PFBC fish culture system typically reduce metabolic waste in the overflow water by 30-50% in traditional coldwater facilities utilizing linear raceways. The first treatment tier also involves the capture and processing of solids from quiescent zones (QZ) during rearing unit cleaning. The solids capture process already employed at PFBC coldwater stations is the utilization of rectangular and (in one case) circular clarifiers. Clarifiers receive wastewater from the QZ via wastewater piping, settle the solids via gravity settling, and then further concentrate the waste for disposal. The separated overflow water from the Tier 1 solids capture treatment is allowed to pass on to Tier 2 treatment (see below). Solids collected by the clarification process require further handling to remove the solid waste from the gravity clarification units. These processes include pumping and/or vacuuming solids to sludge drying beds, sludge storage systems, and land application vehicles designed to remove the waste from the facility and apply it to local lands under landowner agreements. Tier 1B (Table 6) provides a listing of proposed sludge storage systems at PFBC stations to accommodate frequent cleaning of clarifiers and winter non-land application periods. The clarification processes can remove from 60% to 90% of the quiescent zone settled solids.

Table 6. Wastewater Treatment Tiers In Place and Proposed at PFBC Fish Culture Stations

	Tier 1 -- Rearing Unit Cleaning Solids Collection, Clarification, & Disposal	Tier 1B -- Sludge Storage [1]	Tier 2 -- Overflow Water Settling Pond	Tier 3 -- Microscreening of Overflow Water [1]	Tier 4 -- Aeration of Settling Pond (BOD Reduction) [1]	Tier 5 -- Filtration of Overflow Water & High Technology Treatment [1]
Bellefonte	BMPs, QZ, CL	*	SP	*	*	*
Benner Spring	BMPs, QZ, CL	*	SP	*	*	*
Big Spring	BMPs, QZ, CL					* (Recirculation System)
Corry	BMPs, QZ, Municipal System	*	SP	*	*	*
Huntsdale	BMPs, QZ, CL	*	SP	*	*	*
Oswayo	BMPs, QZ, CL	*	SP	*	*	*
Pleasant Gap	BMPs, QZ, CL	*	SP	*	*	*
Reynoldsdale [2]	BMPs, * (New Rearing System)	*		*	*	*
Tylersville	BMPs, QZ, CL		SP	* (Pilot Testing Ongoing)	*	*
Fairview	BMPs, QZ, CL		SP			
Linesville	BMPs		SP			
Pleasant Mount	BMPs, QZ, CL		SP			
Tionesta	BMPs, QZ, CL	*	SP	*	*	
Union City	BMPs		SP			
Upper Spring Creek			SP			

Best Management Practices (BMPs) -- diet manipulation, enhanced feeding regimes, flow baffles, vacuuming and/or cleaning of rearing units, quiescent zones, clarifiers, and settling ponds
Quiescent Zones (QZ)
Wastewater Clarifier (CL)
Microsreening Overflow (MS)
Settling Pond (SP)
Aerated Settling Pond (ASP)
Bed filtration (BF)

* Proposed Wastewater Treatment

(1) Tiers 1B, 3, 4, and 5 are enhanced wastewater treatment technologies that are proposed for incremental installation and evaluation at PFBC fish culture stations. Cooperative evaluation of enhanced wastewater treatment performance by PFBC and DEP including numeric effluent parameter reductions and biological integrity of benthic invertebrate communities, and receiving stream impacts will be required for each tier.

(2) New rearing system is proposed.

The second tier (Table 6) involves the treatment of overflow water that was not impacted by the quiescent zone solids settling and removal. This water typically includes 50% of the solids load that was generated by the feeding process and also includes the entire proportion of dissolved chemical constituents and finer non-settling type particles. Tier 2 type processes currently in place within the PFBC system involve the use of overflow water settling ponds. Currently, all PFBC stations employ settling ponds as a form of Tier 2 treatment. However, these types of settling techniques can produce varied results. The variability of the conditions (algae and accumulated solids) within the ponds can add to the effluent concentrations observed (i.e., organic enrichment). Improvements to the settling ponds have been completed by the PFBC at several facilities. These improvements include plastic membrane basin lining, floating baffles to improve flow patterns and enhance settling, and basin cleaning.

The Tier 3 proposed effluent treatment enhancement (Table 6) involves the use of microscreening with fine mesh drum or disc rotary microscreens and high-pressure backwashing system. Mesh size openings typically range from 10 to 40 microns. Tier 3 proposed treatment will provide for total facility discharge flow microscreening prior to further treatment in settling ponds. Microscreening solids removal efficiencies are variable and range from 20% to 70% depending upon the application, solids concentration, and flow rates. Pilot microscreen testing at Tylersville FCS is now being completed and evaluated by the PFBC as well as other aquaculture microscreening systems now in operation.

Tier 4 proposed effluent treatment enhancement (Table 6) involves aeration in the settling ponds to provide for biological treatment of effluent via microorganisms (algae and bacteria). This proposed aeration settling pond treatment is targeted toward biochemical oxygen demand (BOD) reduction and further improvement in effluent quality beyond solids settling. The addition of aeration systems to the existing PFBC settling ponds is relatively simple to implement using floating jet aspirator and/or other mechanical aerators.

Tier 5 proposed effluent treatment enhancement (Table 6) involves filtration to remove solids remaining from the Tier 4 aerated settling pond microorganism treatment process and other treatment tiers. Media (sand) filtration is often used for removal of residual suspended solids. Sand filtration can be completed in pressure filters, gravity beds, traveling bridge filters, and/or sand seepage ponds with under drains. Removal efficiencies of 80% to 90% for selected parameters are typical for media filtration. Traveling bridge bed filters with air scour media washing are commonly used for final effluent filtration. These systems involve considerable construction and operating cost. Other high technology effluent treatment such as ultraviolet disinfection (UV), ozonation, biofiltration, and chemical treatment are technically feasible but are very expensive to construct and operate.

It is recommended that effluent treatment improvements for each fish culture station be completed incrementally by tier with detailed performance evaluations by the PFBC and DEP to access numeric effluent parameter reductions and benthic invertebrate impacts in the receiving streams. Pilot studies of each treatment tier are recommended to evaluate the efficiency and expected reductions in wastewater impacts within the PFBC system.

Figure 4. Tier 1 & Tier 2 existing PFBC Effluent Treatment

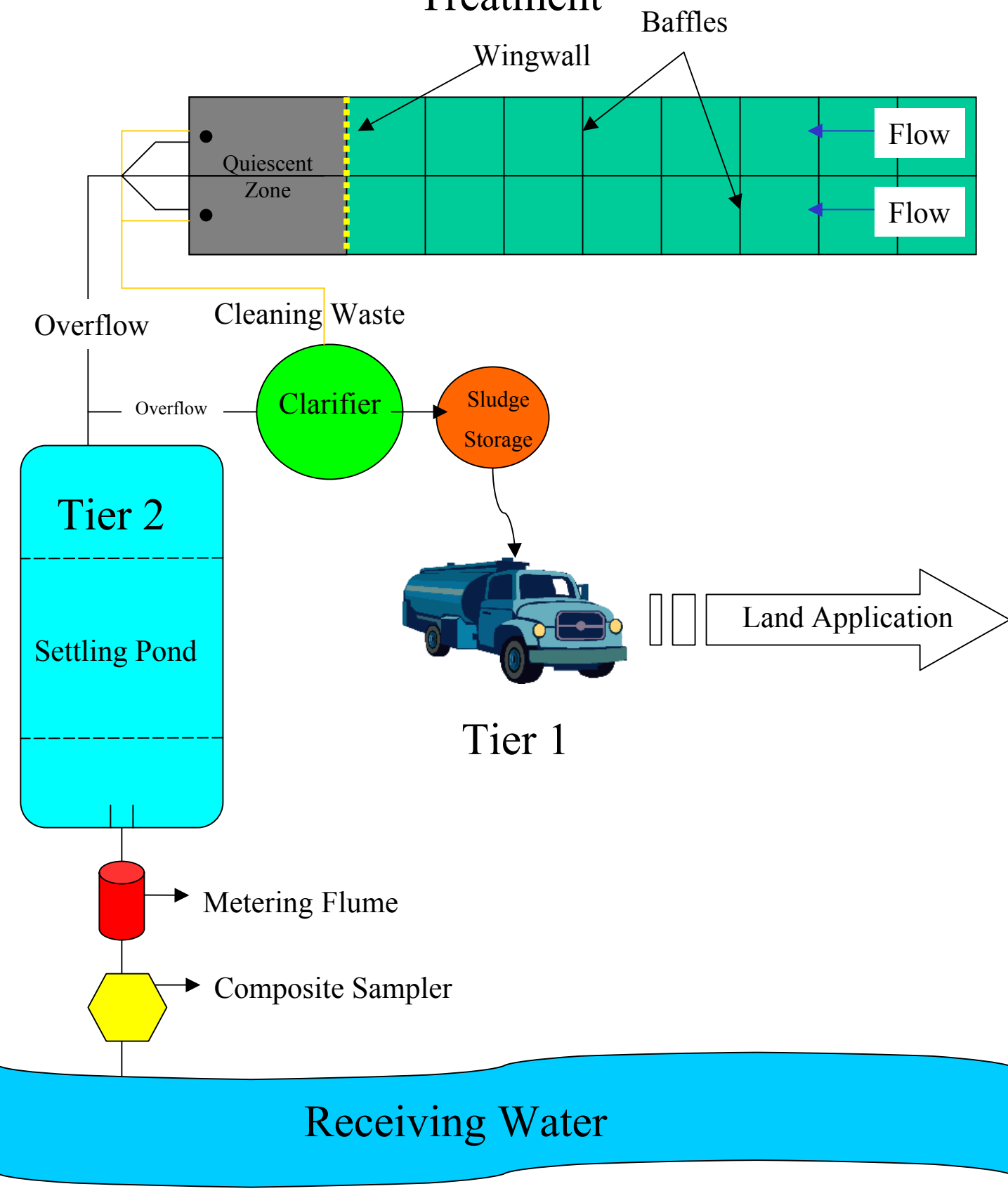
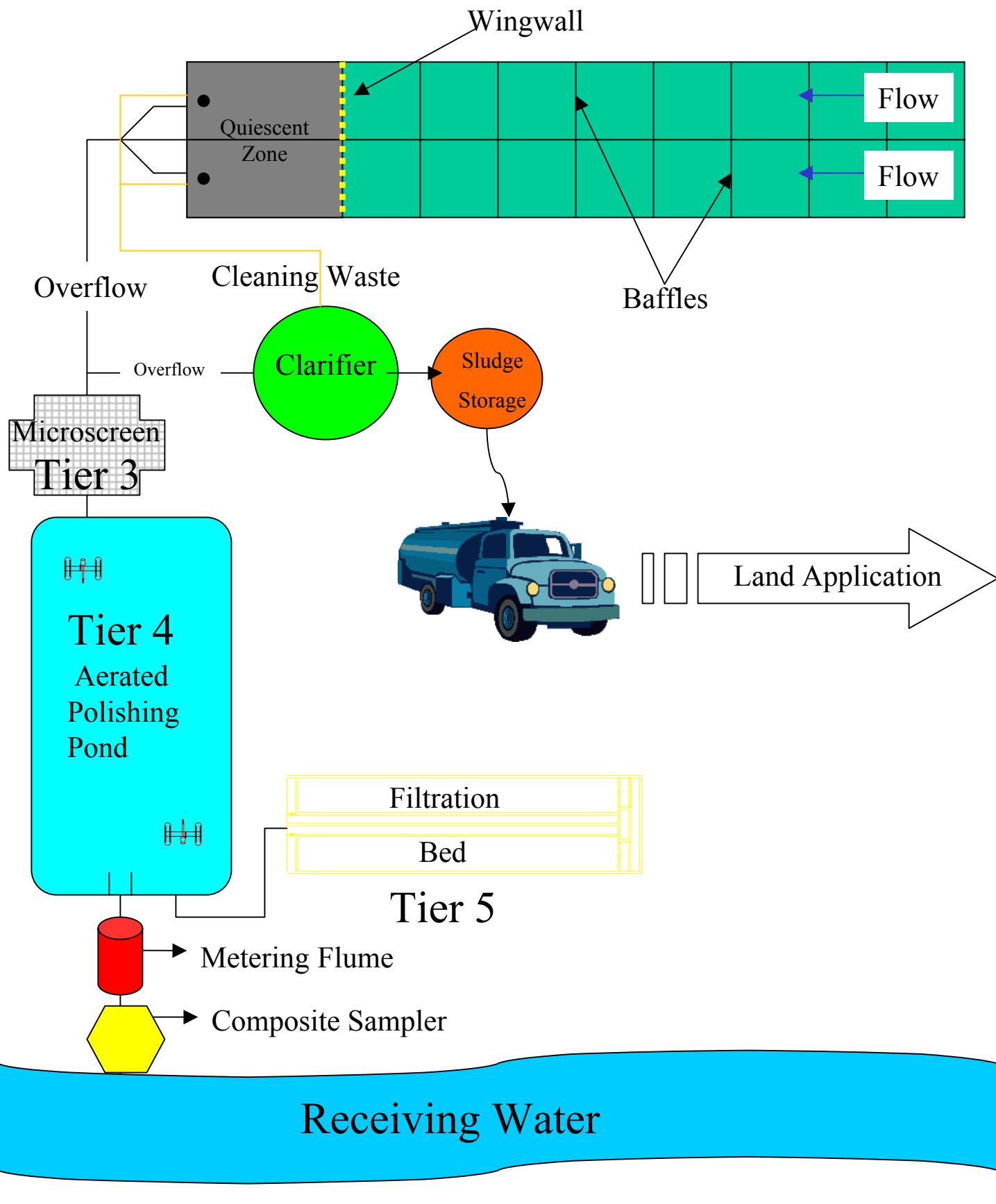


Figure 5. Tier 3,4 & 5 Effluent Treatment Enhancement



Wastewater Modeling & Analysis

Chemical changes in the water utilized by a fish culture station are primarily the result of fish metabolism. Two exceptions are the case-by-case use of therapeutic chemicals or sanitizing chemicals for disease control and the quality of the background water used within the station. The magnitude of fish metabolism depends ultimately upon the amount of the fish (biomass) and the amount of food utilized by the fish. Therefore, the water quality impacts (i.e., effluent by-products) are in direct proportion to the amount of fish food introduced to the system.

Despite some limitations and necessary assumptions outlined in the main report, coldwater fish culture stations were modeled to calculate predicted effluent levels and were compared to the observed results (2001 NPDES discharge data). The wastewater modeling was intended to assess the current wastewater treatment ability and to project future treatment requirements (treatment tiers) necessary to reduce the total mass loading (kilograms) to receiving waters. In general, all stations are discharging less than the model predicted mass loadings of wastewater parameters. Measured discharge less then the predicted number was attributed to effluent treatment processes already in place. While these numbers are believed to be reasonable estimates, slight variations between fish culture stations, feed composition and the effects of background water chemistry produced variations between the predicted and the observed numbers. Additionally, some instantaneous measurements observed by PFBC staff exceeded the monthly average and predicted concentrations (mg/l). These observed "spikes" are attributed to anomalies at the time of sampling and are not indicative of the total mass loadings to the receiving water. Due to the fact that concentration data and not mass loading has been used to develop the new DEP discharge license for PFBC facilities, we believe that a comparison to the food-calculated parameter mass and concentrations is necessary to determine validity and accuracy of the methods used. It is the belief of the consultant that mass based permits more accurately represent and monitor the conditions at each station when compared to the highly variable concentration based permits.

Biological Assessments

Historically, NPDES permits have been written to limit the discharge of conventional and toxic pollutants on a chemical-specific (i.e. parameter) basis. This approach is usually straightforward, but sometimes can result in overprotective, as well as underprotective, permit limits. In the last decade, State agencies have begun utilizing additional measures to assess the overall health of a water body. These measures have centered around the presence and/or the absence of specific species, and habitats upstream and downstream. Known commonly as "Biological Assessments," these measures attempt to accomplish the following:

- Set protection and restoration goals;
- Assess water quality and identify impaired waters;
- Identify stressors to a water body;
- Set restoration priorities through Total Maximum Daily Loads (TMDLs);

- Track restoration progress;
- Support water quality permits and permitting activities; and
- Generally, to protect the watershed.

Simply controlling the substances discharged does not assure the biological integrity of water resources, because that integrity depends on a combination of chemical, physical, and biological processes. Successful protection of watershed quality requires monitoring and assessment tools that measure the interacting processes. Chemical analyses, whole effluent toxicity testing, physical habitat assessment, and bioassessment are four (4) assessment tools that have a unique role in the NPDES permitting process. The information provided from the integrated use of all four assessment tools strengthens permitting decisions and should be used in the evaluations and determinations of NPDES permit compliance (USEPA, 2000).

Several regulatory agencies across the country are utilizing or developing biological methods for waterbody health assessments. These biological methods include fish, benthic macroinvertebrates and algae. A fourth category is the combined use of all three biological methods. Currently (2001), twenty-nine (29) states are utilizing fish biological assessment while forty-four (44) states utilize benthic macroinvertebrates and four (4) utilize algae. A total of twenty-nine (29) state agencies are utilizing a combination of more than one category. Deviations from the USEPA Rapid Bioassessment Protocol (RBP) method have occurred in several states developing biological assessment criteria; however, the careful development of acceptable standards, the use of pilot studies and the development of precise collection methods are common components of each program prior to its use for assessment in state waters.

While some merit has been demonstrated in other states utilizing biological assessments, it does not appear that DEP is applying this method of assessment to other point and non-point sources in the various watersheds. Additionally, the apparent targeting of biological surveys associated with PFBC fish culture stations is concerning. The use of biological standards is ultimately used to make adjustments to the numeric standards outlined in the NPDES permit process. To date, biological assessments are not components of the NPDES program but rather are tools that enhance the classification of waterbodies as impaired or not impaired. In some cases, the assessment process can lead to a 303(d) classification of the Clean Water Act. This classification requires development of a Total Maximum Daily Load (TMDL) watershed model, which ultimately requires a thorough investigation of all watershed sources (point and non-point) of impairment to the reach of the water in question. The end result of the TMDL is the re-development of numeric discharge permit standards. The Pennsylvania Department of Environmental Protection is strongly encouraged to review its biological assessment program and to work cooperatively with PFBC personnel in the development of numeric standards prior to the classification of a waterbody as impaired. Consideration of the combined fish, benthic macroinvertebrate and algae biological assessment technique is also suggested. While some impairment to the receiving waterbodies directly downstream of a fish production facility is inevitable, the PFBC has demonstrated a strong desire to continue as good stewards of the Pennsylvania water resources by implementing wastewater treatment practices to minimize the

impact of FCS operation on receiving streams. This mission and effluent improvement efforts are being overshadowed by the premature classification of a waterbody as impaired. At the present time, it is not known what numeric discharge permit criteria is required to eliminate benthic impairment associated with fish hatchery wastewater.

Privatization Analysis

The subject of privatization of activities traditionally completed by government agencies has received a great deal of attention in the last decade with the current political trend to attempt to downsize government and reduce costs. In an attempt to determine and evaluate private aquaculture's interest, willingness, and capability to produce trout for the Commonwealth's stocking program, a privatization questionnaire was developed. On December 20, 2001, the questionnaire was mailed to one hundred and fifteen (115) private aquaculture facilities within Pennsylvania as well as select facilities in neighboring states. As of May 2002, seventeen (17%) percent (19 of 115) of the private facilities surveyed returned responses. Of the returned responses, only eight (8) private facilities stated that they would be interested in or would consider producing trout for the PFBC's stocking program.

Combined, the eight respondents claimed that they would be willing to produce 943,000 adult trout (number) and 469,500 pounds. It should be noted that about half of the trout were from private aquaculture facilities outside of the Commonwealth. Compared to the PFBC 2000-2001 adult trout production of 5.2 million number and 2.7 million pounds, the private trout producers could account for approximately 18% of the adult trout produced by the PFBC in 2000-2001. Other private facilities stated that they either did not have the water quality required to produce trout (coldwater species) or exclusively produced forage/bait fish. It should be noted that NPDES permit and biological assessment may also be a future issue for private growers.

Recommendations, Improvements and Opinions of Probable Cost

The study provides a series of possible facility improvements including conceptual level improvement drawings and opinions of probable cost for each individual recommendation (see end of this document).

Minor to major infrastructure improvements were identified at all stations and a prioritized list of improvements was developed. Recommended improvements for each fish culture station have been categorized into three (3) priority groups (Priority 1, 2, and 3). A not recommended category (Priority 4 or NR) includes potential improvements evaluated but not recommended.

Priority 1 Items. These improvements are considered essential to the station's ability to meet assigned PFBC fish production goals and compliance with the Commonwealth's operational codes and permits. Enhanced effluent treatment is a system-wide Priority 1 improvements item. Renovation of these systems is generally required to repair deteriorated components and